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Assessment of Municipal Solid Waste Management System in Kaithal City, Haryana

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Abstract

The present study was conducted to study the effectiveness and efficiency of the Municipal Solid Waste management system in Kaithal city and to find a suitable method for MSW disposal. Municipal solid waste generation, composition, and disposal practices were assessed and current challenges in MSW collection, transportation, recycling and disposal were analyzed. For solid waste characterization, the waste was collected regularly from three different socioeconomic status houses for three weeks. Regarding waste collection in the city, door-to-door collection by push-carts and tricycles and also mini collection trucks with separate compartments were used. Collected waste was transferred to community bins and taken by trolleys to the landfill site of Municipal Council Kaithal which is about 5 km away from the main city on Khurana road. Currently, the city residents' per capita solid waste generation rate is 0.326 kg/day with a total generation of 50-60 metric tons/day. MSW generation rate was positively correlated with socioeconomic status. The waste comprised organic (86%), polythene & plastics (3.75%), paper and cardboard (3.88%) aluminium foil (1.50%) and other wastes (4.20%). These numbers suggest a greater potential for recovery of organic wastes via composting and there is an opportunity for recycling. A number of recommendations are suggested for improving the MSW management system.

Keywords: *Waste Collection, Waste Disposal, Municipal Solid Waste Management*.

Introduction

Solid waste generation is a continuously increasing problem Worldwide. Expanding population, urban sprawling, escalating levels of living standards, technological advancement and other factors contribute to a persistent problem of Solid Waste Management (SWM) in India. According to the CPCB, the amount of waste produced per person has grown exponentially (0.26 kg/day to 0.85 kg/day) [CPCB India, 2018a].

As a result, the municipalities have been confronting various problems related to solid waste collection, treatment, and management. The citizens are not much aware of waste management-related issues, and their careless attitude towards their waste, creates challenges for the municipalities. The general public lacks awareness of issues relating to waste management, and their disregard for proper disposal of their garbage presents difficulties for local governments. The potential threat of MSW at disposal sites are emission of dangerous greenhouse gases that eventually results in environmental pollution, which contaminates the groundwater through leachate formation (Li and Zhao, 2001; Ko, *et al.,* 2015; Ngwabie, *et al.,* 2019). Many researchers have noted improper handling of municipal solid garbage in various Indian towns, including Allahabad (Sharholy, *et al.,* 2008), Metro cities (Kumar, *et al.,* 2009), Varanasi (Srivastava, *et al.,* 2020) and Kurukshetra (Grover, *et al.,* 2022). Because important municipal solid waste components are not recycled and composted, poor waste management can have negative effects on the environment, low aesthetic qualities, and the economy.

Under the Swachh Bharat Mission (SBM) as a national campaign by the Ministry of urban development (MoUD), the government of India; local municipal bodies, (ULBs)urban local bodies have to make cities open defecation free and focus on the SWM system with social priorities (Mani and Singh, 2015). Local municipal bodies in India are required to eliminate open defecation in cities as part of the Swachh Bharat Mission (SBM), a nationwide

campaign initiated by the Ministry of Urban Development (MoUD). The SBM also emphasizes the SWM system with social concerns (Mani and Singh, 2015). Municipal solid waste management is currently a top priority for urban local bodies (ULBs), with more of these organizations building new infrastructure and striving to alter outdated, unsustainable processes. This phenomenon is evident in Haryana, where both large and small cities are working to enhance their methods for managing solid waste. Kaithal is an example of this. In the present study, we focus on household waste management with reference to the socioeconomic status in Kaithal city.

Study site

The Kaithal district is bordered on the north and north-west by Patiala district (Punjab), the south-west by Jind district, the east by Panipat and Karnal, and the northeast by Kurukshetra district (Fig 1). Kaithal Town is 48 kilometers west of Kurukshetra. It is located at 760 23'-49" East longitude and 290 42'-9" North latitude. The major town is charmingly positioned on the edge of a big man-made lake known as "Bidkiyar Lake." It is connected to the nearby significant towns of Karnal (60 km), Jind (55 km), Kurukshetra (48 km), and Ambala (48 km) with metalized highways (80 Km). The Kurukshetra-Narwana branch railway-line also passes through this town.

Fig.1: Location of Kaithal city

Kaithal has a dry winter, Humid subtropical climate. The district's average annual temperature of 29.12oC (84.42oF) is 3.15% above the average nationwide for India. Kaithal generally experiences 22.81 wet days (6.25 percent of the year) and receives about 18.31 millimeters (0.72 inches) of precipitation yearly.

Kaithal city is divided into 31 wards. According to Census India's 2011 report, the Kaithal Municipal Council has a population of 144,915 people, 76,794 of whom are men and 68,121 of them are women. The total area of the city is 43.67 sq. km. Kaithal Municipal Council has total administration of over 28,547 houses to which it supplies basic amenities like water, sewerage and other facilities. Previously Kaithal was surrounded by seven ponds and eight gates that are now an old part of the city. And urban sprawling taking place in new habitations towards Ambala, Kurukshetra, Jind and Karnal roads. The old part of the city was planned with an open drain sewage system for water disposal; sometimes waste is also disposed of in them.

Methodology

Selection of Households

A preliminary questionnaire-based survey related to the income and other information required for this study, including the number of household members, education level, and the profession of the head of the family was carried out in various households of various administrative wards of Kaithal City to get primary data. Based on this preliminary survey, a total of fifteen houses were selected from different parts of the city on the basis of their socioeconomic status. Out of Fifteen, five houses were selected from low socio-economic status having annual income below 1 lakh, the other five houses were identified as having an annual income of 1 lakh to 10 lakhs and remaining on the basis of high socio-economic class had an annual income of more than 10 lakhs (Khan, *et al.,* 2016).

Data collection

Primary Data regarding waste generation was collected from the representative houses in the morning for three consecutive weeks to quantify the waste generated, its composition, and the transport mechanism of waste to a disposal site. Solid waste samples were collected from households of different socioeconomic groups and weights were taken using an electronic weighing balance. Collected wastes from each household were segregated first into biodegradable and non-biodegradable components, weighed separately and recorded. Per capita household waste generation was calculated by dividing the total waste produced with the number of household members in that house that day. Waste characterization and analysis were done on-site through manual sorting and visual estimation method and face-to-face interaction helped in knowing the view of residents regarding waste management. A well-structured and self-administered questionnaire was used for the workers at the disposal site comprised of information about waste disposal site and waste management practices followed by municipal workers. Secondary data was collected from Kaithal Municipal Committee and other concerned offices dealing with waste management regarding solid waste generation, collection and disposal.

Results

Solid waste generation, characterization and composition

The solid waste generation in houses is subject to many factors like nature and culture of people, number of people and their socio-economic conditions and commercial factors. There are three main sources of waste generation, major one is household waste and others are roadside litter and market waste. It has been reported that household solid waste comprised a maximum77% of the MSW stream in Kathmandu city (Manandhar, R. 2005). So, the main concern of this study was to assess the household waste generation, characterization and its composition. Generation rates for houses in Kaithal city were found in the range of 60 metric tonnes/day (According to the municipal committee Kaithal). The average waste generation per day was 0.326 Kg/day/capital. As per the other studies reported, Asia generated one-third of total waste, with significant contributions from China (0–0.49) kg/capita/day and India (0.50–0.9) kg/capita/day (Kaza, *et al.,* 2018). The per capita HW generation was calculated by dividing the total waste produced with the number of people living in that household that day (Dangi, *et al.,* 2011). In the present study, middle socioeconomic class areas generated the highest quantity of waste in the study areas; 0.436 kg/person/day followed by the high-class areas, 0.406 kg/person/day and the low-class areas 0.135 kg/person/day for the Kaithal city (Table 1). Results indicated that the medium socio-economic group generated more waste per day per capita as compared to low and high socio-economic groups. Similar results were reported by (Khan *et al.,* 2016; Mani and Singh, 2015) that the medium socioeconomic group generated maximum waste. Different findings regarding waste generation differences among socioeconomic areas where the higher socioeconomic classes generated higher waste have been reported (Asase, 2011) as; 0.63 kg/person/day for Asokwa a high-class area, 0.52 kg/person/day for Atonsu, a Middle-class area and 0.27 g/person/day for Ahinsan, a low-class socioeconomic area all in the Kumasi metropolis. Survey results indicated that the waste generation rate depends on many factors such as no. of family members, lifestyle, attitude towards waste generation and also socio-economic status. It has been reported that in a high socioeconomic family group, day-to-day waste generation rates are usually higher than the lower socioeconomic families (Viswanathan and Trankler, 2003).

Table1: Waste generated by households

S. No		Houses Name	No. of family members	Total Waste Generated per week in Kg	Average waste Produced(kg/ day)	Average waste Produced(kg/ day/capital)
1	Low Eco. Class	House 1	5	9.152	1.307	0.261
2.		House 2	3	4.735	0.676	0.225
3.		House 3	5	0.625	0.089	0.017
4.		House 4	3	0.845	0.120	0.040
5.		House 5	5	4.65	0.664	0.132
Average						0.135
6.	Med Eco. Class	House 6	3	13.51	1.93	0.643
7.		House 7	2	11.732	1.676	0.838
8.		House 8	2	4.725	0.675	0.337
9.		House 9	6	6.485	0.926	0.154
10.		House 10	3	4.455	0.636	0.212
Average						0.436
11	High Eco. Class	House 11	6	23.005	3.286	0.547
12		House 12	10	17.887	2.555	0.255
13		House 13	6	22.65	3.235	0.539
14		House 14	3	5.775	0.825	0.275
15		House 15	6	17.51	2.501	0.416
		Total (n)=15		147.741	21.105	4.896
Average						0.406
		Total Average			1.407	0.326

Houses of the low socio-economic class produced less waste because these houses differ in terms of their family size and difference in their way of living and food habits as compared to houses of High Economic Status. As per the study regarding the comparison between middle-class families and high-class families, the generation rate depends upon no. of family members otherwise generating the same waste on average. According to (Suthar and Singh's 2015) research, waste generation and household family size are strongly correlated.

Waste composition is influenced by a variety of elements, including dietary habits, cultural customs, climate, and socioeconomic status (Gupta, *et al.,* 2013; Srivastava, *et al.,* 2014). Waste composition and characterization determine the waste management criteria. In the present study, waste composition varied in different socio-economic groups of the city. Middle and high-income group people utilize packaged food and beverages and food wastage is more as compared to the low-income group. Similar findings were found

in a prior study, which found that high-income groups use more packaged goods and generate more paper, glass, metals, plastics, and textiles than low-income groups (Sridevi *et al.,* 2012).

Based on the estimations, it was found that the major fraction of waste generated in houses was mainly organic waste i.e.86% included unused food items and vegetable peels, rotten vegetables and Fruits. Others were thin-film plastic carry bags and packaging material 2%, plastic 1.7%, cardboard 2.2%, paper 1.68%, aluminum 1.5% and other waste 4.2% observed (Fig 2) during the survey and varied significantly among different locations of the city. Similar results have been reported in a study that showed food/kitchen waste constitutes about 75–80% part of House hold Waste (Suthar, S., and Singh, 2015). The present survey also reported that the maximum waste generated from the high socioeconomic class was on Monday as compared to other days of the week and from middle and low-income groups waste generated was almost similar throughout the weekdays. It was observed that the hazardous waste generated was negligible. The hazardous waste mainly found was batteries, cells, remotes, computer CDs, empty containers of household insecticides and pesticides etc. which make a 0.03% of the total volume.

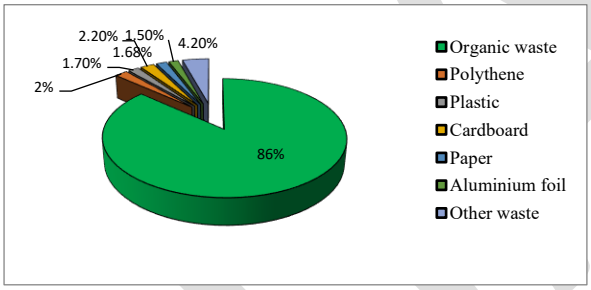

Fig. 2: Composition of Household Waste in Kaithal City

Reduce, Reuse and Recycling

Unused food from households was given to cows and dogs. Some houses send their unused food to slums and provide it to their maids. Waste food was given to piggeries by a few households. Newspapers, bottles, papers, cartons, and cardboard were segregated by some of the households and they sell them to junk dealers. Due to unawareness and lack of motivation, none of the waste management techniques like segregation into organic and inorganic waste, composting, and vermicomposting was used by households in Kaithal city

Collection and Storage of Solid waste

For the city's aesthetics, health, and environment, waste management involves the collection, storage, transportation, and disposal of trash. Solid waste collection and storage involved, door to door collection from household by tricycle and handcarts and transferred to community bins (Fig 3). The collection of the waste is the most important, difficult, complex and costly step in waste management. Most communities spend 60 to 80 per cent of their solid waste budget on solid waste collection (Nathiya and Thandapani, 2019).

Primary Collection of Municipal Solid Waste

Primary collection is the process of gathering rubbish right from the place where it is produced. The primary collection contains "door to door" and "house to house" collections. Approximately 150-200 workers were employed who sweeps the streets, markets and other areas and collect primary waste through carts and tricycle. In the present study, out of 15 houses 7 households dump their waste in carts, 5 in tricycles and 3 disposed of their waste on their own in municipality bins on daily basis. The primary waste collected was a mixed type of waste including both biodegradable and non-biodegradable. According to a study, the majority of Indian cities continue to collect a mixed type of waste [(Ahluwalia and Patel, 2018), Primary waste is collected and transferred to municipality bins. The collection bins used in the city were not properly designed, located and maintained. However, for storage, large-sized community bins had been placed at various locations from where the waste was transferred and transported to a landfill site. Common bins were used for both decomposable and non-decomposable waste (no segregation of waste was performed). Dustbins around the city would regularly flood, making them an ugly sight. Stray animals such as cattle, pigs, and dogs moved around the bins.

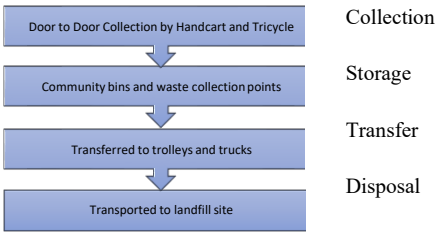

Fig. 3: MSW infrastructure setup of Kaithal city

Transfer and transportation of Solid Wastes

For transfer and transportation, 40-45 labours of Kaithal Municipal Council were engaged, 4-5 persons including a driver per vehicle (in morning and evening shifts) for lifting the garbage from the roadside, drains and large-size community dustbins. Waste was manually transferred to community bins. Kaithal Municipal Council had placed 240 large-sized

community bins (31 of capacity 20 quintals) in each ward. Medium-sized (80 of capacity 6 quintals) and small-sized (130 of capacity 3 quintals) bins/containers by the side of major roads, streets and in the market and commercial areas as mentioned in Table 2. From community bins waste was transferred to trolleys and trucks and transported to landfill site. On average 7 trolleys, 2 trucks and 1 dumper pressure of Kaithal Municipal Council move two to three times a day for this purpose. The trolleys were not covered while transporting the trash. Also, while moving waste, leachate—a liquid that comes from biodegradable waste dripped everywhere.

Table 2: Summary of data provided by Kaithal municipal corporation on solid waste generation, collection and transportation

Total quantity of solid waste generated	60-80 tons/day
Total number of community bins	240 (3-20 quintals capacity)
Number of trucks with a 5metric -ton capacity	2
Capacity (Number of Tractors with a capacity of 2.5 metric tonnes).	7
No of handcarts (volume of 6–9 cft).	70
No of tricycles	62
Waste collection mini trolleys	25

Solid Waste disposal site and its condition

For the Disposal of waste, a new landfill site was identified and given by HUDA Haryana Urban Development Authority Kaithal at Khurana Road Kaithal in 2013-14. Previously waste had been disposed of on open dumping grounds. It was a new initiative by Kaithal municipal committee which is quite better than open dumping. This landfill site has been stretched in 5 acres of land.

Fig. 4: (a) MSW deposition in landfill site of the Kaithal city. (b) landfill site overview

The landfill site was semi-scientific in its structure. Regarding its construction half acre of the land was cemented, and two and a half acres was not-cemented (kuchha floor). The remaining two acres of land was 30-40 feet deep dugged and excavated for landfilling as shown in Fig 4(a). The base of the excavated land was chemically treated and cemented (pukka floor) to avoid mixing of leachates with groundwater. Landfill site was surrounded by a boundary wall of seven feet and entrance to the landfill for waste-disposing vehicles was from connecting road instead of the main road to avoid disturbance on road. Waste disposed of here was neither segregated nor processed and remained uncovered. Heaps and heaps of waste were dumped on daily basis whereas; waste was compressed by JBC only once or twice a month. Similar findings have been reported by various researchers about the unscientific disposal of waste at open dumps. Mostly, about 90% of the total were still dumped on the spacious grounds and it's rare to find capped sanitary landfill sites. In the present study, between 80-90 % of municipal waste was disposed of in landfills without using adequate management techniques. Whereas open burning had also been observed, leading to air, water and soil pollution (Joshi and Ahmed, 2016). According to the India state report (Indiastate.com, 2009) the MSW generated in the Indian cities had a high proportion of biodegradable items (>40–60% of the total) which can be utilized effectively for composting operations. In the present study, at the Landfill site, several scavenging birds and animals such as crows, eagles, pigs, and dogs have been observed and also rag pickers arrived at the disposal site and caused problems by spreading the waste. The situation becomes very deplorable during monsoon season when waste was mixed with water in the site and stagnant water leads to foul smell and the origin of many diseases. According to Municipal Corporation it will last for approx 10 years.

Table3: General conditions of Disposal Site

Sr. No.	Conditions of disposal site	Respondents
1 (a)	Distance from the Kaithal city	5 km
(b)	What type of Location	Plains
(c)	What type of disposal practice	Landfill
(d)	How far from the populated area	2 Km
2	**Observation on disposal site**	
(a)	Boundry wall	Yes
(b)	Ragpickers	yes
(c)	Cat	No
(d)	Dogs	Yes
(e)	Pigs	Yes
(f)	Eagles	Yes
(g)	Smell	Yes (Foul smell)
(h)	Blowing of waste by wind	Yes
(i)	On-site segregation	No

Challenges faced by Kaithal Municipality

Major issue identified in Kaithal was unsegregated MSW. The segregation of MSW was not organized or scientifically planned. It was neither at the household level nor at the community bin level. Sorting of waste was hardly practiced by waste producers, whereas ragpickers accomplished sorting and segregation at disposal sites or near the community bins where very unsafe and hazardous conditions were there. As the ragpickers segregated only valuable discarded constituents from the waste stream, which provided them higher economic benefits in recycling, the effectiveness of segregation was comparatively low (Kaushal, *et al.,* 2012). Without segregation scientific disposal of waste was not possible (Singhal and Pandey, 2001). Another challenge was collection efficiency, which was not 100 % because some inhabitants tend to dump their waste in the empty plots, nearby public space, or low-socioeconomic populations sometimes simply burn it in their backyards. One more challenge was the current landfill site capacity that was inadequate for the quantity of waste generated. A new site has to be identified for the near future. Besides from these issues, the failure of MSW Management can also be attributed to underqualified people, incorrect technical expertise, insufficient budget, lack of accountability, and the application of laws and policies. Public attitudes to waste are also a major barrier to improving SWM in Kaithal city.

Conclusion

The waste generation rate was 0.326kg/capita/day and as per the study household waste generation rate was maximum in mid socio-economic families of Kaithal city. The municipal committee was providing essential services like community bins, and workers for sweeping, collecting waste, and transferring and disposing of off to the dumping site but sustainable management of solid waste in Kaithal city will be achieved if solid waste collection efficiency is increased and improved proper waste segregation recycling, and composting are adopted at the household level. Further proper management of the system is required which will be possible only if public participation become an integral part of SWM in Kaithal. Semi-scientific landfill site was a new initiative better than open dumping but the solid waste needs to be disposed of more scientifically. Recyclable portion of the waste should be segregated so that reduction in the quantity of final waste can be achieved. Disposal and organic waste need to be processed through composting, vermicomposting, anaerobic digestion or any other appropriate biological processing to minimize the burden on landfill. A leachate-collecting or gas-collecting system needs to be installed at the landfill site.

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